THE TELEGRAPHIC JOURNAL.

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ON THE

ABSOLUTE ELECTRO-MAGNETIC UNITS OF RESISTANCE AND ELECTRO-MOTIVE FORCE, WITH SUGGESTIONS FOR THEIR RE-DETERMINATION.

At the late British Association Meeting at Belfast a very important communication with the above title was made to Section A by Professor G. Carey Foster.

Kirchhoff and Weber were the first to devise methods of measuring electrical resistance in absolute electro-magnetic measure. Subsequently, Sir W. Thomson suggested a method for the same purpose to a Committee of the British Association, by whom a series of measurements were carried out at King's College in 1863. The results of these experiments have been accepted throughout England, and the B.A. unit has passed into general use as the "Ohm." In Europe, however, its employment has been but partial, and its accuracy has lately been questioned by Continental physicists. M. Kohlrausch has lately, by a most careful series of experiments, determined an absolute unit which differs considerably from the ohm, and in his paper (which has been translated into the *Philosophical Magazine*) he assigns his reasons for supposing the ohm to be wrong. Still more recently, Professor Lorenz, of Copenhagen, has by another method made a determination which differs from both the preceding.

The extent to which the three sets of experiments differ is shown by the following comparison: the absolute resistance of a Siemens mercury-unit is—

According to the Brit. Assoc. Committee ...	0·9537
" Kohlrausch	0·9717
" Lorenz	0·9337

Thus, although the results are not concordant, the value obtained by the Committee is intermediate between those given by the other two determinations. With these discrepancies in the results, it is obviously desirable that this most important physical measurement should be repeated with all possible precautions to ensure accuracy.

Foster's method consists (like any other) in determining the ratio of the electro-motive force to the strength of the current produced by it in a given conductor; and then, since—

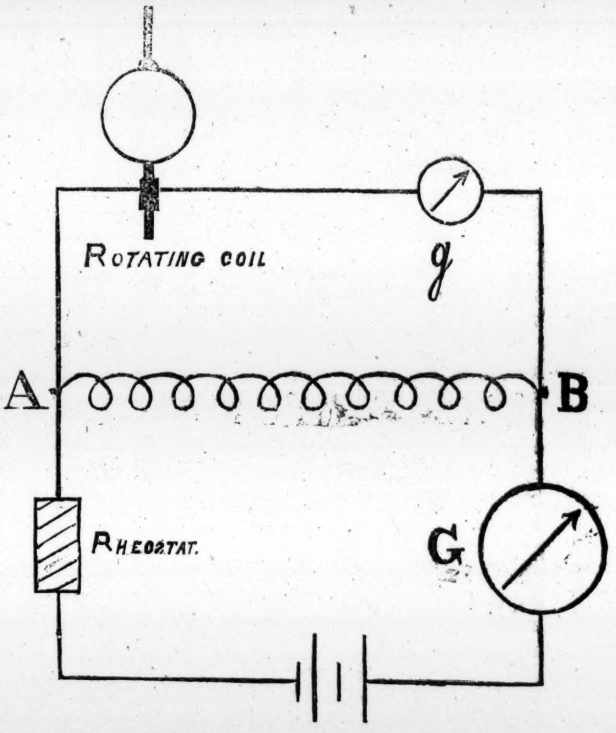
$$\frac{E}{C} = R,$$

the resistance of the conductor is determined.

For this purpose a large coil of covered copper wire, like a hoop placed vertically, is made to rotate about a vertical axis, so as to have a certain electro-motive force E generated in it by the horizontal component of the earth's magnetic force. During each half-revolution beginning and ending with the plane of the coil at right angles to the magnetic meridian, the mean value of E is—

$$\frac{2aH}{t},$$

where a is the effective area of the coil, t its time of revolution, and H the earth's horizontal intensity; but during successive half-revolutions the sign of E is alternately positive and negative. The ends of the wire of the coil are connected with a commutator on its axis (as in an ordinary Delezenne's circle) which causes the current in all external portions of the circuit to flow in only one direction. This being arranged, all that would be wanted, in order to know the resistance of the wire of the coil, would be to measure the strength of this current, and calculate the electro-motive force by observing the speed of rotation. But it is plain that the resistance so calulated would include the resistance of the commutator, which is variable and wholly irregular, so some modification is necessary which shall entirely eliminate this source of error. Prof. Foster manages this by applying Poggendorff's method of measuring E.M.F., that is, by stopping all current in the coil with a branch of an auxiliary stronger current. A constant battery (shown in the diagram) has its circuit completed through a Siemens unit, a standard coil, or other conveniently-mounted resistance, A B, which it is desirable to know in absolute measure. A certain difference of potential exists between the ends of the wire A B, and this can readily be altered by changing the resistance of other parts of the circuit till it is precisely equal to the electromotive force generated in the coil when revolving at some constant rate. There is a delicate Thomson's galvanometer, g, in the coil circuit, which shows when the two differences of potential are equal by the absence of all current through it; and when this point has been attained, the battery circuit is totally unaffected by its connection with the coil. The strength of the current in A B is now to be very carefully measured in absolute measure by an accurate absolute tangent-galvanometer, G; this current is produced by an electro-motive force E (which we have arranged to be equal to the difference of



potential between the ends A and B) acting against the resistance R of the wire A B; but the electromotive force of the coil is also E, and therefore it could produce exactly the same strength of current against the same resistance R. Thus the strength of the current which the calculated electro-motive force E of the coil could produce against the required resistance R is measured when there is no current at all circulating in the coil. The absolute resistance of the wire A B is now known, for—

$$R = \frac{E}{C} = \frac{\frac{2a\,H}{t}}{k\,H \tan\delta} = \frac{2a}{k\,t \tan\delta}$$

k is the constant depending on the particular tangent galvanometer, and has of course been previously determined.

The horizontal intensity of the earth is eliminated from the result, as it appears both in E and C, and this is important, since it is a thing very difficult to determine accurately and is liable to local disturbances.

The principle of the process is now clear, but there are numerous details, of which we may mention some. First, the current in the coil is intermittent, while the battery current is continuous. If the coil rotated very fast this would be of slight consequence, and it might perhaps be got over by discarding the battery and substituting a second coil, more powerful than the first, but rotating on the same axis; the current in this is to be used in the same way as the battery current was used; they will then be equally intermittent.

Secondly, it is impossible to keep the velocicy of a coil, rotating at a high speed, perfectly constant, so that the needle of the galvanoscope g will be continually oscillating about its position of rest, corresponding to slight variations in the rate of rotation. By applying a method used by Cornu in his measurement of the velocity of light, Prof. Foster proposes to use a varying velocity with as great accuracy as a constant one. A sort of triple Morse instrument is to discharge a broad strip of paper under three independent markers; one is to mark seconds, or other convenient units of time; another is to record each revolution, or ten revolutions of the coil; while the third is to be worked by hand, and is to be depressed whenever the needle of the galvanoscope is observed to be near its position of rest. The tangent-galvanometer must be read while this last key is down, and then from the strips the actual rate of the rotating coil can be afterwards ascertained with a high degree of accuracy.

The advantages of the whole method which are peculiar to itself, are, first, that the wire whose resistance is to be measured may be of the most convenient form and material for accuracy and constancy, and any wire whatever may be measured just as easily as any other; second, that the strength of the current is not measured by some arrangement inside the revolving coil, but by an independent accurate tangent-galvanometer, whose sensitiveness may be so adjusted that the needle may be deflected about 45°; and, further, that by applying Bosscha's modification of Poggendorff's method (that is, after measuring as before, add a certain resistance to the wire A B, and then compensate it by a known addition to the external circuit, and so on) the E.M.F. of any cell may be compared directly with that of the coil, and so found in absolute measure.

In the discussion which followed—

Prof. Guthrie and the President (Prof. Jellett) both doubted whether the irregularities in the resistance of the commutator were wholly got rid of by the method.

Prof. Foster explained that as when the measurement is to be made there is no current in the coil, a change of resistance can have no effect. If the circuit were properly balanced, the needle of the galvanoscope would remain at rest, whether the resistance of the commutator were 0 or ∞; the only thing is that if the resistance of the commutator were infinite the coil would be disconnected, and there would be no experiment; so the effect of an increase of resistance at the commutator is to diminish somewhat the *sensitiveness* of the method, but it has no effect on anything else.

Prof. Clerk Maxwell said that the method seemed capable of furnishing very good results, and was well worth putting into operation. He said, also, that the change of resistance at the commutator was entirely eliminated, but that the change of E.M.F., due to heat at the contacts, was not; however, Prof. Lorenz had used a revolving commutator and had not been much troubled by this effect, and he got rid of what little there was by reversing the current in different experiments. The commutator must be accurately made, so as to cut off the current a definite proportion of each revolution.

Prof. Wiedemann said it would be important to measure the area of the revolving coil accurately, and this he thought might be found the most difficult part of the experiments.

Prof. Maxwell then explained a contrivance he had devised for ascertaining the dimensions of large coils, by letting a wheel (on whose axle a string could wind itself) roll on the wire as it was wound on, and afterwards running this wheel along a scale till the string was unwound. The length of the wire and number of turns is thus known, and from these the effective area of the coil is easily found. Prof. Maxwell further suggested that the commutator should only make contact for a very short time in each revolution, as this would do away with any self-induction (or extra currents) which might take place if contact were made long enough for the current to vary much in intensity.

This last seems a valuable suggestion, and is probably the best way of getting over the intermittent current difficulty (which the double coil arrangement, if we have understood it correctly, does not seem well calculated to meet); for if contact were only made while the coil was cutting the lines of force at right angles, this maximum E.M.F. could be balanced by the battery circuit, so that the needle of the galvanoscope would be at at zero; and at times in the revolution when the E.M.F. in the coil became less, the resistance at the commutator would be infinite, so the galvanoscope needle would remain at zero. The battery current would be quite unaffected by this change, since the possible branch circuit through the coil would always contain either an equal opposing E.M.F., or an infinite resistance, so the tangent galvanometer needle would be always steady.

We hope that Prof. Foster will speedily have an opportunity of putting his admirable method into execution.

IMPROVED THERMO-ELECTRIC BATTERY.

By M. C. CLAMOND.

In the Telegraphic Journal for April 1st we gave a brief abstract of M. Clamond's experiments on thermo-electric batteries. The following full report of the paper read by M. Clamond before the Paris Academy of Sciences will doubtless be of interest to our readers:—

The thermo-electric battery which I call *thermo-electric generator* possesses nothing absolutely new. But by its construction, and mode of heating, it is an essentially practical and industrial apparatus, since it combines the double quality of producing an energetic and constant current with a small volume of gas. M. Farmer made the first attempt at constructing these kind of batteries, and he showed two of his models at the Paris Exhibition of 1867. They had the fault of rapidly losing their strength; the bars were excessively fragile, and broke in cooling. In May, 1869, M. Becquerel presented to the Institute* a thermo-electric pile which had been constructed by myself, in conjunction with M. Mure, with couples of galena and iron plates (see Telegraphic Journal, vol. i., p. 11). It showed that the weakness of the current proceeded not from the diminution of the electro-motive force, but from the augmentation of the resistance of the apparatus.

This increase cf interior resistance was due to two causes:—1. Oxidation under the influence of heat. 2. The splitting of the bar, and separation of its different parts in planes perpendicular to its length. I have avoided the first inconvenience by a particular arrangement of the fastenings of the plates. The second inconvenience was much more difficult to overcome. When a thermo-electric body, either a metal or a metallic sulphide, is run into a cold mould of a cubic shape, three planes of separation parallel to the faces of the cube are formed, so that we obtain thereby eight separate cubes. These partings are not visible at first, but, after having repeatedly heated the mass, one perceives on breaking it, the existence of these three planes by some black layers which prove the oxidation of these interior surfaces. This fact may be explained thus: All thermo-electric bodies, when deprived of elasticity, and all more or less brittle, separate into distinct parts, which crystallise on the sides of the mould. Thermo-electric substances which have been run into cold moulds are exceedingly fragile. It has been proposed to improve their physical condition by annealing. Though annealing gives a more solid appearance, it does not prevent the splits. I have mounted batteries with annealed and with unannealed bars, both galena and metallic alloys, and have always remarked that the annealed bars became weak much more rapidly than the others. The conditions to ensure obtaining homogeneous bars are to annihilate the influence of the mould's sides, and as much as possible to prevent crystallisation. For this purpose I successfully employed a process analogous to that used to give solidity to wax candles,—viz., the mould being heated to a temperature very near the point of fusion of the thermo-electric substance, the latter is poured in very near its point of solidification.

For the construction of my couples I adopt an alloy of zinc and antimony, used by Marcus, and plates of iron for the other pole. The first was chosen because the alloy of zinc and antimony is a good conductor of electricity.

It is known that zinc and antimony alloy possesses its highest thermo-electric property when it is composed of equal chemical equivalents of the two metals composing it. Now experience has led me to reduce the potential of my bars in such a manner as to gain in quantity what is lost in potential. Thus the model shown deposits twenty grammes of copper per hour, and the same model constructed with similar bars of a more powerful potential only deposits twelve grammes an hour. This demonstrates that the resistance of the bar diminishes faster than its electro-motive force, and that in reality the constant $\frac{E}{R}$ of the couple increases. It thus results that the most energetic bars are not those which constitute the most energetic batteries. Thus constructed, these batteries are not subject to deterioration, and I have used one for six months without witnessing any variation in it.

Regarding the arrangement of the battery, the bars are collected in crowns, and coupled in series. These crowns, each composed of six bars, are placed one on top of the other, and separated by washers of asbestos. The whole forms a cylinder whose interior is luted with asbestos, and heated by means of a refractory clay pipe, pierced with holes. Gas mixed with air passes through the holes of this tube, and burns in the annular space between the tube and the bars.

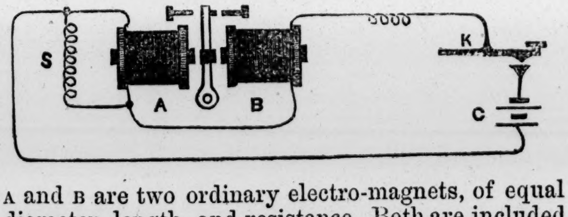
The expense of working such a machine has already been referred to in vol. ii., p. 157, of this Journal, and further information respecting details of construction will be found in vol. i., p. 11, where three illustrations are given.

ON A NEW FORM OF RELAY.

By T. A. EDISON.

I have taken advantage of the induced currents set up within the coils of an electro-magnet at the moment of closing and opening the circuit to construct a telegraphic relay, the lever of which is worked or controlled by them.

The accompanying diagram will serve to illustrate the principle—



A and B are two ordinary electro-magnets, of equal diameter, length, and resistance. Both are included in the same circuit, together with a battery, C, and key, K.

The magnet A is permanently shunted with a resistance, S, twice as great as that of the magnet.

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* Institute of the Academy of Sciences, Paris.

The armature or tongue is so adjusted that it will remain in contact with either point when the circuit is permanently closed, the same as the tongue of a Siemens's relay when no current passes through it. It should also remain where placed when the circuit is interrupted. The operation is as follows:—Supposing that the lever is in contact with the point on the left, and the circuit be closed, the iron cores of the magnet B acquire their magnetism almost instantly, while the induced current from A, being provided with a current of low resistance formed by the shunt s and magnet sets up an opposing electro-motive force to the primary current, and delays the magnetisation of the cores of A, and allows B to attract the armature. If the current is now interrupted, B instantly loses its magnetism, while the secondary current from A circulating within the closed circuit in the same direction as the primary current, prolongs the time of demagnetisation, and this secondary or after magnetism attracts the armature to the left.

It is obvious that the greater the resistance of the circuit in which A and B are placed, the greater will be the difference in the induced currents set up by A and B. When the resistance of the current is small the induced current from B acts only upon closing the circuit, and reduces the differences, but by increasing the resistance this current is proportionately weakened, while that from A remains constant.

When properly constructed this relay is one of great delicacy.

The speed by which signals can be relayed into a secondary circuit is fully 18 per cent greater than with a Siemens relay.

A greater difference in the charging and discharging times of the two magnets may be obtained by increasing the length of A.

Newark, N.J., U.S.A. Aug. 28, 1874.

THE DEVELOPMENT, COURSE, AND DURATION OF EXTRA CURRENTS.

THE nature of the extra current which appears on closing an electric circuit, can be studied in two ways. The current may be isolated (as M. Edlund has ingeniously done), or the inquiry may be made, how the primary current behaves in the moment of closing the circuit. The study of this *variable* part of the electric current furnishes an answer to the question considered, inasmuch as the extra current is no other than that portion which the primary current *wants*, after closing, in order to become constant. This second way is the more simple and natural, no special experimental arrangements being required; while only those difficulties are present which arise from the extreme shortness of the time in which the complicated phenomenon occurs.

The subject has recently been investigated by Prof. Blaserna, of Rome, and his results are communicated in the Jubilee Volume of *Poggendorff's Annalen*.

The method he adopted was, in general, to close the circuit for a longer or shorter time, to measure this time very accurately, and to observe also the deflection produced by the current in an astatic multiplier needle.

No doubt, when a circuit is quickly closed and then opened, not only the primary current itself, but also the extra current at opening, accompanied with a spark, goes through the galvanometer. But this, it can be shown, has little influence on the galvanometer; the spark-current has its intensity reduced almost to zero, through the resistance of the air.

The author had a wooden cylinder constructed, with metallic strips fitted in its surface; these were in metallic connection with each other, and with a small metallic cylinder on the same axis. The two cylinders were rotated together; two steel springs, with platinum knobs, pressed lightly on the two cylinders, and they were connected with the two poles of a battery; thus, during rotation, the circuit was alternately closed and opened, according as the spring on the larger cylinder pressed on metal or on wood. The duration of closure of the circuit could be determined from the breadth of the strips, and the number of rotations. The latter was ascertained acoustically by means of a siren.

Suppose the cylinders turning at a constant rate; a multiplier in the circuit will receive a series of equal impulses, and the needle show a constant deflection. If the rate of rotation be altered, so will the deflection; the number and value of the impulses becoming different. The two deflections are not directly comparable together, because they are dependent on two variable factors. The value of an impulse is shown to be equal to $\frac{J}{n}$, where J is the intensity of a constant current, which would produce the same deflection, and n is the number of revolutions in a second. By proceeding gradually from a low to a high velocity, a great many different values of these two quantities are obtained, and M. Blaserna accordingly constructs a curve which he terms the *curve of surfaces*; and from this he deduces another, *the curve of intensities*, in which any inequalities in the former are greatly magnified. For the exposition of these points, and the tables of experimental numbers, we must refer to the paper, and will here only state the conclusions at which M. Blaserna arrives:—

1. At the moment of closing, the current immediately begins to flow. Its intensity increases, at first slowly, then more quickly, and reaches a maximum, then sinks to a minimum, rises again to a weaker maximum, &c., and completes a series of ever-decreasing oscillations until it reaches its normal ultimate value.

2. These oscillations are such, in reference to the final value, that probably the greatest maximum does not attain the double value, and the smallest minimum does not reach zero value.

3. The oscillations are more numerous and marked, the stronger the induction spiral, *i.e.*, the stronger the extra current. For straight conductors these oscillations are insignificant. If we consider the line representing the final value of intensity of the current as axis of abscissæ, the same curve, only referred to this new axis, will represent the extra current on closing; whence it follows, that this consists of a large number of opposite, quickly-succeeding currents, forming a system of true oscillations.

4. The extra current at opening consists also of quickly successive and opposite currents, but its

intensity is much greater, and its course much more rapid.

One point considered was, How long does the variable condition last? In his experiments, the author still found traces of oscillations after 2-100ths of a second; and, with more delicate instruments, he thinks they might be followed further. The duration of oscillation was estimated at three to four 10-1000ths of a second; hence 50, or perhaps 100 decreasing oscillations may be required before the current reaches its constant strength. The duration of the separate oscillations becomes greater and greater.

Prof. Blaserna compares his results with those got by three other observers—Helmholtz, Rijke, and Weber. Helmholtz concluded from his experiments that the intensity of the current during the variable stste rises according to the law of an exponential curve, without oscillations, becoming at length constant. M. Blaserna points out that the curve of surfaces from the experiments shows two inequalities, and the curve of intensities must therefore have presented two oscillations. M. Rijke studied the duration of extra currents by Weber's method, sending short currents through the magnetometer, and the bifilar electro-dynamometer. As in the former, the deflection for each small element of time is proportional to the intensity and the time; in the latter, proportional to the square of the intensity and the first power of the time; two equations are obtained from which intensity and duration can be determined. This method (our author affirms) is only applicable if the intensity is given as function of the time, *i.e.*, when the problem is already in great part solved. In all other cases, one has to be content with very rough approximations, which may lead to quite false results. Thus Rijke comes to the remarkable conclusion, that the extra current at opening has considerably less intensity, and greater duration, than that at closing; whereas, from all analogies, the opposite might be expected, and actually occurs, as the author's experiments prove.

Lastly, M. Weber has considered the point whether in long conductors the electric waves are propagated with a determinable time; and he concludes that in a wire 73 kilometres long "there are no observable differences of phase." From this it follows that even in such long wires the separate parts are at the same time in exactly the same electrical condition, but it does not appear from the research how exactly this condition is produced. Now we know that in conductors oscillations occur, and we may therefore infer, according to Weber's data, that these oscillations, which have, for electrical conditions, a very long duration, occur simultaneously in the whole conductor, at least so long as the length of wire does not exceed 73 kilometres.

THE ELECTRO-MOTOGRAPH.

THE following extremely interesting discovery, which is likely to be of considerable practical importance in telegraphy, was communicated by Mr. Edison to a recent number of the *Scientific American*.

The salient feature in Mr. Edison's discovery is the production of motion and of sound by the style of the Bain telegraph instrument, without the intervention of a magnet and armature. By the motion thus produced, he works any of the ordinary forms of telegraph printing or sounding instruments, or relays, and is enabled to send messages, by direct transmission over thousands of miles of wire, at the highest speed, without re-writing, delay, or difficulty of any kind. More than this, his apparatus operates in a highly effective manner, under the weakest electric currents, and he is able to receive and transmit messages by currents so weak that the ordinary magnetic instruments fail to operate, or even give an indication of the passage of electricity. Thus, when the common instruments stand still, owing to feebleness of current, the Edison telegraph will be at full work. The author has named his discovery the electro-motograph.

Here is Mr. Edison's own letter on the subject:—

In my new system of telegraphy, it would seem that power was obtained, or that electricity had been passed into a new mode of motion, as with magnetism; but this is only apparent, not real, if I understand it right.

The electricity, acting by electrolysis, changes the nature of the surface of the paper, either by depriving it of some constituent, or the hydrogen, in conjunction with the metal and paper, form substitution compounds, the surfaces of which are smoother than the paper in its natural state, in the manner that the surface of rough paper is made smooth by dipping it into sulphuric acid. The strangest thing connected with this phenomonon, however, is this:

In trying to ascertain what caused the lever to move, whether it was by reducing the lead by hydrogen to a finely divided powder that acted as a lubricant, or whether the nature of the surface of the lead were changed by the absorption of hydrogen, like palladium, or whether the effect were due to the effort of the gases to escape from under the lever—I was led away from these notions by finding that platinum, with sulphate of quinine, will likewise show the movement. It then struck me that the nature of the paper was changed by the electrolysis. To test this, I had a long message received over the Automatic Telegraph wire from Washington (this wire runs in my laboratory at Newark), and recording the same on ordinary chemically prepared paper. The speed with which the message was sent from Washington was about 800 words per minute, and the colorations forming the dots and dashes were rather faint. I then passed the strip into the electro-motograph (I use this name for the want of a better one), the colorations being in a direct line with the lead point. On rotation of the drum, and when no coloration was under the lead point, the lever was carried forward by the normal friction of the paper. But the moment a coloration passed under it, the lead point slid upon the paper as upon ice, the friction was greatly reduced, and the lever moved in an opposite direction to the rotating drum.

In this experiment no battery was connected to the instrument. This proves that electrolysis produces a change in the nature of the paper.

I afterwards found that if a tin pen were used to receive a message from Washington, although no marks were seen, the paper appearing unchanged, yet, on passing the paper through the instrument, the movement of the lever was more marked than before. Receiving the message with a lead pen did not give so good results, although lead is the best when used, standing at the head of the twelve metals tried. The next is thallium. On paper moistened with aqueous solution of pyrogallic acid, tin is as good as thallium. Of all the solutions yet tested, potassic hydrate has been found to give the most marked results. The second best is sulphate of quinine. Third, rosaniline oxidised and discoloured by nitrous acid.

A peculiarity of the quinine solution is that platinum shows an action, and shows it when either oxygen or hydrogen is evolved on its surface. With hydrogen the friction is lessened, as with all other metals; but with oxygen the friction is increased. This is so with all the metals subject to oxidation; but it appeared strange, at first, that it would show with a metal upon which the nascent gases had no effect.

With a lead point, and a solution of the disinfectant known as bromo-chloralum, the evolution of hydrogen increases the friction of the paper enormously.

Silver seldom shows a movement with any solution; and when it does it is very weak.

Sulphuric acid shows least movement with any metal.

It appears to be a matter of indifference as to the character of the metal used for the drum, which acts as one of the decomposing electrodes. Considering that the lever will close a secondary circuit under the great pressure used upon the lever, its sensitiveness to electricity is wonderful. With a delicately constructed machine, moved by clockwork, which I have nearly finished, I have succeeded in obtaining a movement of the lever sufficient to close the local circuit with a current (through 1,000,000 ohms, equal to 100,000 miles of telegraph wire), which was insufficient to discolour paper moistened with potassic iodide, or move an ordinary galvanometer needle. Messages may be read from the sound of the lever, when the most delicate telegraph magnet shows no current.

The uses of this instrument are many; in fact, it gives an entire new system of telegraphy.

As no secondary currents are generated, as with an electro-magnet, to prevent the instant magnetisation or demagnetisation of the iron cores, and electrolysis being instantaneous, it is obvious that the lever will respond to signals transmitted with great rapidity. I have succeeded in transferring signals from one circuit to another at the rate of 650 words per minute; hence it may be used to repeat the rapid signals of the automatic telegraph into secondary circuits.

By attaching an ink wheel to the extremity of the lever, opposite a continuous strip of paper moved by clockwork, messages transmitted at a speed of several hundred words per minute may be recorded in ink. By attaching a local circuit to the repeating points, and adding thereto a sounder, it may be used as a Morse relay to work long lines of telegraph.

T. A. EDISON.

Newark, N.J., August, 1874.

QUICK TELEGRAPHING.

No question is more frequently asked of those who are employed on telegraphy than that as to "How long a message will take before it is delivered?" The answer, to be correct, is anything but easy; because it depends, first of all, upon the electrical condition of the lines; secondly, upon the nature of the apparatus by means of which the message is sent; and, thirdly, upon the number of transmissions (that is, transferring from one instrument to another) which it will have to undergo. Several instances of quick telegraphing have been brought under our notice of late, but the following shows the perfection to which the cable telegraph service has been brought. In December last a message was sent from New York to London, and in *thirty minutes*, actual time, the answer was received in New York. On Thursday, the 5th February, another despatch was sent to London, to which a reply was received in *thirty-five minutes*, actual time. In neither of these instances was any special effort made to hurry the answers, but the party addressed sent the reply to the London office by the messenger delivering the original message.

To fully appreciate this wonderful achievement we must consider that the distance from New York to the cable station at Heart's Content, N.F., is about 1300 miles, that of the cable about 2000 miles, and of the land lines and cable from Valentia to London about 300 more. Each message, therefore, was transmitted about 3600 miles, and passed through the hands of eighteen persons, all told; consequently, the message and reply, in each case, passed through the hands of thirty-six persons, and travelled over 7000 miles in thirty to thirty-five minutes. We do not think that this can easily be beaten, and the progress made within the last fifteen years, in the facilities for communication between countries so widely separated, is truly marvellous.

In the TELEGRAPHIC JOURNAL for January 15, 1874, a paragraph appeared recording the feat of telegraphing the President's message of 12,325 words in one hour and twenty minutes through some of the American wires. We afterwards received a letter from the Secretary of the Automatic Telegraph Company at New York, enclosing a report of what their Company has done, and of which we append the text.

NEW YORK, JANUARY 28, 1874.—The President of the Western Union Company having set forth, in a published letter to the Postmaster General, under date of December 27, 1873, concerning the Automatic or fast system:—(1) that the Automatic system is slower than the Morse; (2) that it requires five times as many operators; (3) that consequently it is more expensive; the Automatic Company determined to test the accuracy of these statements by a public demonstration over their line of one wire between Washington and New York. The trial took place on the evening of the 27th inst. By invitation, several electricians were present. The matter transmitted was the President's late message, with the Spanish protocol attached, numbering 11,130 words; it having been selected in consequence of the declaration that its transmission over eight wires by the Western Union Company on December 2, 1873, in 70 minutes, was a feat unparalleled in telegraphy. The work commenced in Washington at 5.39 P.M. The document was copied complete in New York at 6.48 P.M., occupying in all but 69 minutes, as against 70 minutes, the time consumed by the Western Union Company. The average time was 55½ minutes as against 59 minutes by the Western Union Company. The Automatic used but *one* wire, the Western Union Company used *eight*. The Automatic used ten perforators, thirteen copyists, and two Morse operators, as against sixteen expert Morse operators by the Western Union. In the demonstrations made, let it be borne in mind that on the one side the work was done by the ablest experts in the world, and a company with years of experience. On the other side, except the Morse operators necessary to manipulate the wire, our force had not that experience which is requisite for expertness.

Automatic Telegraph Company,
66, Broadway, New York, January 28th, 1874.

HON. GEORGE HARRINGTON, President.—SIR,—I respectfully submit the following report of the work done in the demonstration made on Tuesday evening, January 27th, as per your instructions of prior date. The matter selected for the purpose was the President's late message and the Spanish protocol.

STATEMENT.

Matter transmitted	11,130 words.
Length of Circuit	281 miles.
Conductors used	1 wire.

Labour:

New York	Morse operator ..	1	Total, 25 operatives.
	Copying operatives	13	
Washington	Morse operator ,,	1	
	Perforating operatives	10	

Time:

	P.M.	Mins.	
Washington—			
Perforating commenced	5.39	45½	Total time, 69 mins.
Perforating completed..	6.24½		
New York—			
Copying commenced ..	5.42	66	
Copying completed ..	6.48		

Cost:

Morse operators.. ..	100	dols.	per month.
Automatic operatives	40	,,	,,

The characters were perfectly legible and well defined, and were copied with great facility. The average time during which the perforating operatives were actually at work was 45½ minutes, making an average per operative per minute of 25 words. The average time of copyists was 50 minutes, making an average per copyist, per minute, of 17 words. Unlike the Western Union Company, we had no large corps of operators from which to select our working force, but were compelled to utilise *all*—good, bad, and indifferent, which makes it proper to call special attention to the above averages made. The whole time consumed was 69 minutes, as against the published record of 70 minutes by the Western Union in their late effort. The average time occupied by the Automatic was 55½ minutes. The average time occupied by the Western Union (as reported) was 59 minutes. An unfortunate defect in the paper caused much delay in the transmission, otherwise still less time would have been consumed. No attempt, however, was made to attain a high speed of transmission on this occasion, as that point has already been yielded, and incontestably proved, in the presence of the Hon. Jno. A. Cresswell, Postmaster General, and numerous other gentlemen, including senators and representatives in Congress, on the evening of December 11th, 1873, when we transmitted some 12,000 words over our one wire from Washington to New York in 22½ minutes. Our operatives were congregated at Washington and New York on Monday, January 26th, and were tested for the first time on the evening of that day. I call attention to this, in anticipation of the charge that the time which has elapsed since the publishing of the message has been improved by our operatives in practising upon it. With the experience gained in this demonstration, I am confident that in another we could readily dispense with at least two perforators and three copyists, and yet perform a like amount of work.—Respectfully,

E. H. Johnson, General Manager.

New York, January 28th, 1874.

We were present in the office of the Automatic Telegraph Company last evening, whilst they were receiving the President's message, and the Spanish protocol, from Washington. At 5.39 P.M., Washington signalled that the perforating had commenced. At 5·43 the first portion of the message was received, and handed to the copyists. At 6.42 the last portion was received. At 6.48 the copying was finished: the whole time occupied being 69 minutes. There were thirteen copyists in the room; but we noticed that two or three were unemployed a portion of the time, so that, had all been constantly employed, there would have been several minutes saved in the aggregate. The writing was perfectly legible, and the copyists translated with great facility.

(Signed) Jas. G. Smith, A. G. Supt. A. & P. & Franklin Tel. Cos.
H. G. Pearson, Assist. Postmaster, N.Y.
Edward W. Serrell, C.E.
James H. Wilson (of Winslow & Wilson).
Hiram Barney.

Washington, D.C.

E. H. Johnson, Esq., General Manager.—At the test which took place on Tuesday evening, January 27th, the late annual message of the President, together with the Spanish protocol, amounting in all to 11,130 words, was perforated by ten perforators, and transmitted automatically, by one Morse operator, in the following time:—

Perforating commenced..	5.36	P.M	Time, 45½ minutes.
Perforating completed ..	6.21½	,,	
Transmission commenced	5.40	,,	Time, 59 minutes.
Transmission completed	6.39	,,	

The above is New York time, as computed by Washington Observatory time. Respectfully.

P. B. Delany, Manager.

Having witnessed this test throughout, we can certify to the correctness of the above statement.

(Signed) Robert D. Lines, Post Office Dept.
D. J. Gibson, U.S.A., Acting Signal Officer.
H. W. Howgate, U.S.A.
J. H. Lathrop.

INSTRUCTIONS AS TO CABLES.

The following practical instructions concerning preservation and repairing of cables appears in the New York *Journal of the Telegraph*. To some of our readers these instructions may be useful, and to others who, from practical experience, have improved on the methods here given, we invite any suggestions they may offer.

1. No portion of a cable should be exposed to the sun or air, but should be carefully covered all the way from where the water is at its lowest mark to where the connections are made with the air line.

2.—The shore end of cables should be carefully boxed or bedded. Where a cable is led up a shore, make a trench of good depth from below low water mark to the building or box where it terminates. Encase the cable in a double box, so that, if possible, no part of the cable can be alternately wet and dry. Cover with solid plank and stone. At draws where the cable comes up direct from the water to the *connecting* box, that part of the cable from below the lowest water mark to the highest must be carefully wrapped with such material as the electrician may direct.

3. Lightning arresters must be kept at all times attached to each conducting wire of a cable where air line connections are made.

4. In repairing cables, it is first of all necessary that the hands of the repairer be absolutely clean. No grease, water, or dirt of any kind must be allowed to touch the gutta-percha, or the parts to be connected. The fingers should be used as little as possible.

5. In making a joint, do as follows:—First, free about four inches of the conducting wire from the gutta-percha covering, untwisting and separating the wires forming the core, and straightening them. In removing the gutta-percha, be careful not to nick the wires, and leave the end of the gutta-percha of equal length around the core. The separate wires are then carefully tinned by the use of a good soldering iron carefully heated, rosin, and solder in which tin is in good proportion. If there be five wires forming the core, cut three of them so that they shall protrude one and a half inches from the solid gutta-percha covering, the remaining two being left the full length for wrapping. Draw the wires together so that the three short wires shall lap each other about three quarters of an inch, and which will then be soldered together without wrapping. The two free wires of each end will then be neatly twisted from the centre, each wire passing round the core at least three times, giving the joint, when done, the appearance of a single wire wrapped six times around the core from the centre of the joint on each side, the whole joint being about half an inch long. The ends are then cut off

closely, and the points carefully compressed and rounded so that no points appear.

When this is done use the soldering iron over the whole joint, without applying additional solder, until the contact is seen to be perfect and smooth. All this must be done with the utmost care; first, not to over-heat the wire, and, second, to see that the tinning is made on a perfectly clean and dry surface, and the contact of the joint perfect.

When this has been carefully done, scrape or pare off with a sharp knife the outside of the gutta-percha coating of each wire for about two inches from the naked wire and tapering thereto, so that the gutta-percha shall be absolutely clean, otherwise it will not unite with the wrapping. Failures are generally the result of want of cohesion between the new gutta-percha wrapping and the old, caused by unclean or wet surfaces.

6. Before proceeding to cover the wires, the ends and soldered joint are first cleaned with naptha, then a stick of Chatterton's compound warmed, and a small quantity put on the joint and properly tooled over, so as to cover the joint equally. Before applying the tooling iron it is carefully wiped.

The ends of the gutta-percha are then slightly warmed, and the actual end nipped off with the fingers. One side of the percha is then well warmed for about two inches back, and then brought forward over the joint of the opposite side with a twisting motion by the moistened fingers; the opposite end, after heating, should then be brought forward over the other part in a similar manner, as far as it will go, and the percha is again warmed and kneaded with the fingers and thumb.

After kneading, it is again warmed slightly with the spirit lamp. The compound is then heated, and applied over the gutta-percha, by putting the compound stick on the percha, and rolling it along. The compound is warmed and applied a sufficient number of times to go thoroughly over the percha. The joint is again warmed, and the compound properly tooled until it covers the joint uniformly.

A sheet of gutta-percha, well cleaned (the gutta-percha sheeting as supplied to jointers is cut into strips four inches long, and kept carefully in a bag or case), is then warmed, and a piece of about one inch long cut off with a pair of scissors, whose edges are moistened against the lips. The joint is then warmed with the lamp, and also the piece of sheet, which is then applied to one end of the joint, half an inch on the old core beyond the pull down, and being firmly pressed, is drawn along the length of the joint to an equal distance on the other side. The superfluous end is then cut off, the joint is next turned over, and the spirit lamp applied so that the heat warms both the joint and the sheeting. The sheeting is pinched round the joint, and slightly pulled, so as to make adhesion better. The spare sheeting is then cut off with the moistened scissors close to the joint, and a warm tool passed over the seam, so as to open it again, when it is again pinched up, thus forcing out any air that may be in it. In pinching up the last time one edge ought to overlap the other slightly, so that the warm tool may properly seal up the seam.

By cutting off the sheet too far from the joint the seam cannot be reopened, and by cutting off the sheet too close no seam is left, and there is necessarily a vacant space in the vacant covering; this is a frequent fault, and should be avoided. By use of the tool the ends of the coating are made to amalgamate with the old material. The joint is then warmed thoroughly, and kneaded with the thumb and forefinger, care being taken to preserve its shape, and to knead evenly all round. It is then rubbed with the moistened hands.

The stick of compound and the joint are again warmed, and the compound is rolled over the joint from end to end. The joint is again warmed, and the compound is worked and spread over it by means of the tooling iron, in an even and uniform manner. The joint is again manipulated with the fingers, and then heated for the last time, and rubbed well with the hand moistened. This rubbing must be done uniformly and equally all round. It tends to solidify the joint, and gives it that highly polished and finished appearance so characteristic of the handiwork of a good jointer. The best thing found for moistening is saliva.

It must be remembered that if the gutta-percha is heated till it smokes it is useless, and must be thrown away. Use nothing for heating with a blaze. Gutta-percha once burned cannot be restored. If applied merely by softening with hot water, the parts will not unite permanently, and will open.

7. Pole lightning rods are required to be attached to the first, third, and tenth pole on each side of all cables, in the following manner:

Beneath the butt of each pole appointed to have a lightning rod, shall be laid a coil of at least three circles of No. 8 clean galvanised wire, the same to be extended up a small grooved gutter, prepared for it, until it extends one foot above the top of the pole. From this upright wire cross wires, reaching to within an inch of each main wire, or the binding wire of the insulator which supports it, shall be attached. These rods to be secured by suitable iron staples as may be necessary.

Chatterton's Compound.—This compound, by means of which the alternate coatings of gutta-percha upon a cable conductor are cemented together, is composed of the following ingredients:

Stockholm tar........	1 part	by weight.
Resin	1 ,,	
Gutta-percha	3 ,,	

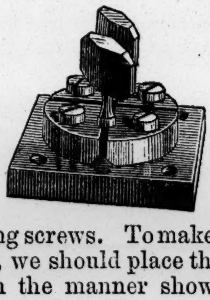
Students' Column.

Resistances and their Measurement. By H. R. Kempe.

XIII.—

Fig. 21 represents the simple form of battery switch which we mentioned in our last article. The poles of the battery would be attached to two contiguous terminal screws, and the leading wires to the two remaining screws. To make the current flow in one direction, we should place the plugs between the segments in the manner shown in the figure, and to make it flow in the other direction, between the other segments. If one or both the plugs are removed the battery current will be cut off altogether. It is always best, in order to do this, to remove both the plugs in preference to one only, for if the battery is not well insulated a portion of the current may still be able to flow out of the battery and disturb the accuracy of a test.

FIG. 21.



Two other pieces of apparatus are necessary to form a very complete set, viz., a "condenser" and a "discharge key."

The condenser is merely a Leyden jar exposing a large surface within a small space. It is made of sheets of tin-foil placed in layers between thin sheets of some insulating material, such as gutta-percha tissue, parraffined tissue-paper, or parraffined mica. The alternate layers of tin-foil are connected together, so that two sets are formed corresponding to the outside and inside layers of the Leyden jar. An excellent description of the manufacture of condensers, by Mr. Culley, has already appeared in the pages of this Journal (Vol. ii., p. 154).

A very convenient form of condenser, manufactured by Messrs. Warden, is shown by Figs. 22A and 22B.

FIG. 22A.

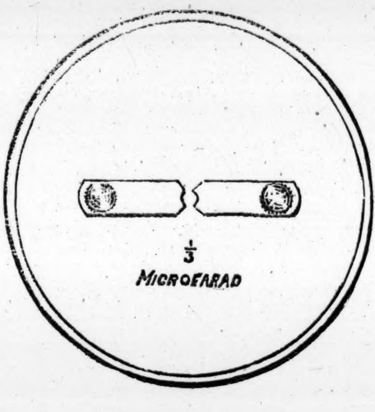
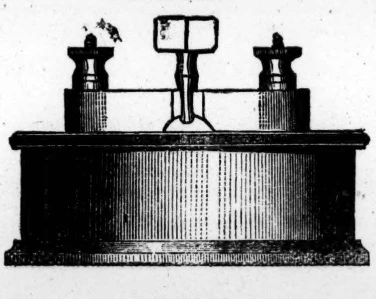


FIG. 22B.

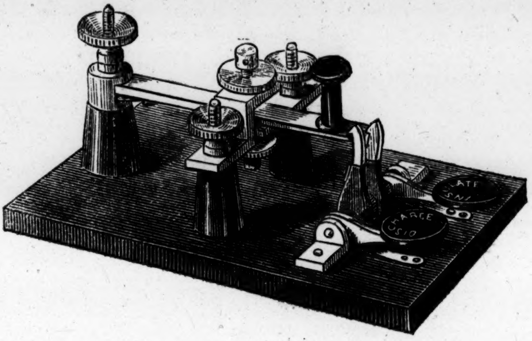


The layers of tin-foil and insulating material (parraffined mica, we believe) are placed in a round brass box with an ebonite top, on which are fixed the connecting binding screws. These binding screws are placed on brass blocks, the ends of which are in close proximity to one another, so that a plug can be inserted between them for the purpose of enabling the apparatus to be short-circuited. This should always be done when the condenser is not in use, so that any residual charge which may remain in it after use may be entirely dissipated. The "electrostatic capacity" of these condensers is usually about $\frac{1}{3}$ microfarad, the farad being the unit of electrostatic capacity adopted in this country.

To enable the discharge from the condenser to be read on the galvanometer a discharge key is necessary. This, like the other pieces of apparatus, is made in a variety of forms. The form shown by Fig. 23, from a cut kindly lent by Mr. C. Becker, of Messrs. Elliott Brothers, was introduced by the British Telegraph Manufactory, and is a very convenient and useful one.

It consists of a lever (which should be a solid lever and not a spring), hinged at one end, and playing between two contacts attached to two binding screws. Two finger keys, near the other end of the lever, marked "discharge" and "insulate," are connected to two ebonite hooks. The height of the hook attached to the finger key marked "discharge" is a little higher than the other hook, so that when the lever is hitched against it it (the lever) stands intermediate between the two contacts. When the lever is pressed down against the bottom contact the shorter of the hooks hitches it down. If in this position we press the "insulate" key down the lever is freed from its hook, and springs up against the second hook, thus insulating the lever from either of the contacts. Now, on pressing the "discharge" key down, the lever at once springs up against the top contact.

FIG. 23.



To the hook of the "discharge" key there is a small piece of metal fixed which is broad enough to come in front of the second hook, so that if the "discharge" key is pressed down first it draws back both the hooks thereby, if the lever at starting be hitched to the bottom contact, allowing the lever at once to spring up to the top contact. If, however, the "insulate" key be depressed, only the hook attached to that key is drawn back, allowing the lever to spring up against the second hook, the lever thus being insulated as at first explained.

Although not perhaps absolutely necessary, it is advisable to have a second set of resistance coils (which need not, however, be of the bridge form) to act as an adjustable shunt for the galvanometer. Also, a simple form of galvanometer to enable the resistance of the Thomson to be quickly taken is useful.

The form of bridge coils most generally used with the Thomson galvanometer, which we gave in No. 22 of this Journal, is that shown by Fig. 4, the keys attached to the other form not being used.

Having now described some of the chief instruments used for making delicate measurements and tests, such as would be required for cables, accurate experiments, &c., we shall proceed to show some of their uses and the different ways of *joining up* for various tests.

The instruments being for the purpose of enabling causes of error which would be inherent in the less delicate forms of apparatus to be as far as possible eliminated, we must determine the best way of using them.

We have already shown that the deflections on the scale of the Thomson galvanometer, except when they are nearly the same, are not correctly proportional to the current strengths which produc them. To obtain perfectly correct results, then, we must adopt some method of avoiding these widely different deflections. This we can do by using a variable shunt for the galvanometer, and with it obtaining one uniform deflection for all measurements made in one set of tests. It should be understood that the graduated scale on any galvanometer is not necessarily for the purpose of enabling the strengths of two or more currents to be compared by different deflections, but also for the purpose of enabling any deflection which may be obtained to be reproduced when required. It is always best to obtain as high a deflection as possible on the scale, for then not only will a slight variation from the correct resistance of the shunt cause a greater number of degrees of variation from the deflection it is required to obtain than would be the case if a low deflection was used; but also a higher resistance being required for the shunt a greater range of adjustment is given to it.

(To be continued.)

Notices of Books.

Notice sur les Travaux Scientifiques de M. TH. DU MONCEL. Paris: Gauthier-Villars.

WE have received the above brochure, comprising in a convenient form a complete list of the works of that indefatigable French philosopher, and reprinting the various papers he has at different times sent to the Académie des Sciences at Paris. The Count is an ardent inquirer into the practical and theoretical branches of the science of electricity, which he has largely enriched with much useful original research, as his contributions to our columns testify. The labour entailed in the mere cataloguing of his numerous papers is in itself very considerable. To give some idea of what the author has done, we quote the following principal scientific publications:—1, "Exposition of the Application of Electricity," in five volumes of 500 pages each; 2, "On Ruhmkorff's Induction Apparatus," a work of 400 pages; 3, "Study of Magnetism," 300 pages; 4, "Researches on the best Conditions for Constructing Electro-magnets," 132 pages; 5, "Treatise on Electric Telegraphy," 600 pages; 6, what may be termed a "crowd" of pamphlets of every variety of title, all of them containing much valuable information on such subjects as batteries, electro-magnetism, induction, &c. That M. Moncel had invented many electrical instruments we were aware, since he received a first-class medal from the Paris Exhibition of 1855, but that his medals now number so many as twenty-four is certainly a most surprising fact, and speaks of unwearied industry, combined with an inventive genius all too rare.

Theory of Arches. By Professor W. ALLAN, formerly of Washington and Lee University, Lexington, Va. New York: D. Van Nostrand, 1874.

THIS little work is the eleventh number of a science series in course of publication. It forms a concise explanation of the various formulæ occurring in that branch of engineering which relates to the construction of arches and bridges, and is an amplification of Professor Rankine's chapters on that subject. The author commences his exposition with a consideration of the forces acting upon a suspended chain or cord under various loads; eight cases of different conditions being taken to exhaust possible contingencies. Next in order the theories relating to arches themselves are discussed. Then we have the well-known principle that the arch may be represented by a reversion of the curve of the cord, and the cord itself replaced by a thin metal strip. Such an arch will be identical with that of the cord under equal and similarly distributed loads; and that if the loading is changed in distribution the curve will change in shape, just as the cord would do under similar circumstances. We think the method Professor Allan has adopted will recommend this little pocket volume to the use of engineers.

Trattate Elementare delle Misurazioni Elettriche ad uso Degli Ispettori ed Impiegati Telegrafici. Di LATIMER CLARK. Prima Traduzione Italiana dell' Originale Inglese, per L. S. PICCO. Geneva: Tipografia del R. Istituto Sordo-muti.

THIS is a fair Italian version of Mr. Latimer Clark's well-known work, with additions and annotations by the editor, who is Inspector of the Italian Telegraphs.

A Treatise upon Railway Signals and Accidents. By ARCHIBALD D. DAWNAY, Assoc. Inst. C.E. London: E. & F. N. Spon.

Siemens Brothers' Railway Bell Alarums and Telegraphic Apparatus.

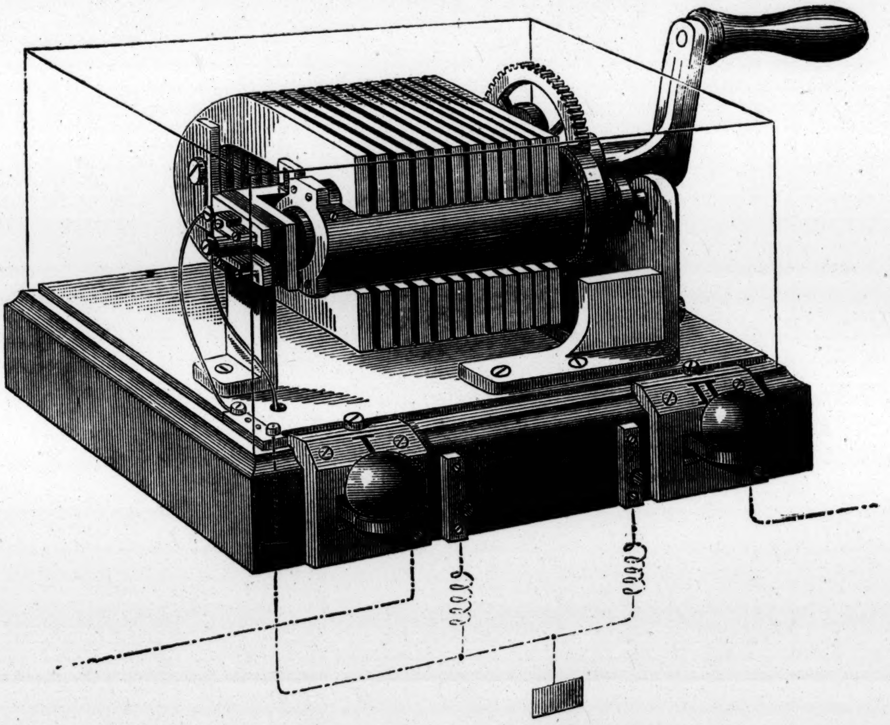
Tyer's Block Telegraph and Electric Locking Signals Fifth Edition.

MR. DAWNAY says that out of 600 to 1000 persons killed, and more than double that number injured, annually on our railways, an average of 25 persons are killed and 1000 injured from causes beyond their own control—an average so large, that every endeavour should be made on the part of railway companies to prevent it. The great number of disastrous accidents so frequently occurring, and of which we have a recent instance on one of the Eastern Counties lines, proves that the present system of conducting railway traffic needs considerable revision; for, though admirable as a system, it yet has defects that occasion great loss of life. The accident just referred to may be apparently attributed to the want of a double set of rails, but in numerous cases the cause is the irregularity of signal workings, or the break down of other mechanisms. The signalling system has grown with the railways themselves. Its defects have been often made manifest by failures resulting in accidents; and the object of Mr. Dawnay's work is to show how the system now in use has gradually branched out from crude and varied materials, improving year by year, as accidents exposed its weak points. There still remains a great deal of room for revision, and we are informed that railway companies are generally disinclined to adopt the various recognised improvements, "from either a mistaken economy, or wilful neglect," and that in 1872 there arose "nearly 300 direct causes of accident," mostly preventible if such improvements had been in use. This is a large percentage, and it is surely not unreasonable to require that every passenger conveyed by a company "should demand, and be entitled to every possible known means being employed to ensure his safety." It is very instructive to read Mr. Dawnay's account of the rise and progress of railway signals, from which we at once perceive the great difficulties companies must have had to contend with in the construction of a recognised general system out of the many totally different ones that existed in the early stages of railway enterprise.

That directors will not adopt every invention we can easily understand, as continual alterations, besides entailing great loss of capital, would require their servants should unlearn their old routine to relearn the new; whilst the inventions might after all turn out to be no improvement. But when such universally known, and palpably evident, advantages as the absolute block system affords are entirely ignored, on the plea of expense, in spite of the warnings of repeated accidents, one is bound to consider that sometimes passengers' lives are weighed in the balance against pounds, shillings, and pence, and are found wanting.

Accidents, however, frequently happen, not from the failure of the system, but from negligence on the part of the servants to follow out the prescribed rules of that system. This is a very important element, because, however good a system may be, it becomes *nil* if its regulations are not in all respects punctiliously observed; through such neglect the "block" system may become no "block" at all. To prevent the possibility of such a state of things, mechanisms should be devised which shall warn and draw the attention of drivers, signal men, &c., to approaching trains, and which shall visually or orally indicate what is needed to be done. It is very gratifying to observe that the attention of patentees has been drawn to this very subject. Messrs. Siemens Brothers have patented an electric bell alarum, especially useful where pointsmen, gatekeepers, &c., may be stationed, and which is already extensively adopted on the Continent. It serves to call the early attention of linemen to the approach of a train by strokes on a gong that can be heard a distance of 500 yards, so that it is impossible for the lineman, unless wilfully, to neglect attending to such duties as may be imposed upon him. The gongs are 6 to 24 inches in diameter, and are attached by a telegraphic wire to each other. "The bell is composed of an electro-magnet, which attracts its armature" and sets some clockwork in motion. This clockwork, moved by means of a weight, makes one or two heavy hammers strike a certain number of strokes against one or two large bells. The defects of the old bell alarum, upon which this is an improvement, worked by a galvanic current, are:—1. Irregularity of battery power. 2, The signal apparatus depends on the action of *one current*, or *one interruption of current*, whereby a delicate and frequent adjustment of apparatus was required. 3. All electric apparatus on the principle of *one current*, or *one interruption of current*, are liable to be influenced in exactness through atmospheric electricity, so as to give wrong signals. Now in Messrs. Siemens Brothers' alarum all these faults, arising from the use of batteries, have been eliminated by the employment of powerful and constant magneto-electrical inductors, whose currents do not change in strength, and, possessing sufficient quantity, is not considerably influenced by the changes of atmospheric moisture, and the consequent leakage of the line.

Fig. 4.



This inductor is so important a portion of the bell alarum-apparatus, that we do not hesitate to give the illustration below. It consists of twelve permanent magnets, between which a cylindrical armature is mounted. The armature revolves 26 times when the handle is turned once round; each complete turn of the armature produces two currents in opposite directions in a coil of insulated wire forming part of itself. The apparatus has two keys or plungers, I and II., so that, by pressing them down, currents can be sent both on the up and down lines. A most ingenious part of Messrs. Siemens Brothers' bell alarum is that the guard, by inserting keys into the machine and turning them once round, can telegraph his message (according to the key used), in the Morse alphabet, to the distant bell. Different keys are used —one to telegraph, say, "Engine broken down;" another, say, "Train off the line," &c.; so that the action on the part of the lineman is purely mechanical, and he is relieved as far as possible of all power of making mistakes.

Messrs. Tyer and Co. have also shown themselves alive to the great necessity that exists for improvements in telegraph signalling apparatus. Their handbook describes their "block" signalling apparatus, comprising patents granted from and after the year 1869. One of the most important of these patents is one dated 1873, and designed to prevent the entrance of lightning into their instruments, so that it is impossible with this improvement for atmospheric electricity to endanger the efficient working by reversal of the magnetic poles. The improvement consists of the exterior indicator on the dial being acted upon by a piece of steel suspended near to one of the poles of an electro-magnet, and this electro-magnet, being in direct communication with the battery, is rendered powerfully magnetic during the transmission of each signal, thereby causing the piece of steel itself to become likewise magnetic. So soon as the current ceases to flow, the electro-magnet parts with the greater portion of its magnetism, while the steel, retaining it, is thus enabled to maintain the required deflection, precisely as if it were held over at the expense of a persistent battery current. The coils being wound with thick wire, allow *ordinary* charges of lightning to pass freely to earth, without injury to the instrument. Such a charge gives an *incorrect* or *unintelligible* signal, which the signalman must, before he proceeds with his signalling, assure himself is not from the distant station.

Papers on the block system of working railway traffic, by Mr. W. H. Preece and Major Mallock, will be found in vol. i., pp. 137, 138, 156.

We doubt not that when improvements such as those we have referred to are more widely used by railway companies, that the high rate of death and injuries resulting from what are termed "unguardable" accidents will be greatly, if not entirely, reduced. Board directors must eventually see that the adoption of safe instruments, though costly at the outset, will in the long run be cheapest for themselves, since by mistaken economy they put by their savings with one hand only to pay them away in compensations with he other.

Electrical Science in English and Foreign Journals.

(In addition to our usual abstracts, there will be found under this heading the titles of papers on electrical science which have appeared in English and foreign journals from the commencement of the present century up to the date of the establishment of this journal).

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxix., No. 9. August 31, 1874.

A correspondent, M. P. Volpicelli, communicates a curious instance of the effect of imagination upon certain nervous patients. He says a doctor, enjoying an excellent reputation, maintained that if a magnet was brought near a nervous subject, the magnetism had divers effects upon him. He, M. Volpicelli, was invited to experiment upon one of the patients in the Saint-Esprit Hospital, at Rome. The invitation was accepted; but, instead of taking a magnet, a piece of ordinary iron was carried to the patient, who no sooner saw it than he fell into convulsions. On a second occasion the same individual was made to attend a scientific meeting, and was surrounded by magnets ntroduced into his chair, in the drawer of the table at which he sat, and even under his feet, but without producing the slightest effect. During the *seance*, which lasted for two hours, he experienced no nervous symptoms, and stated he was in perfect health; and on being informed that he had been surrounded with powerful batteries expressed more surprise than fear, as though he were not sure of being quite so well. These experiments M. Volpicelli considers to be satisfactory proofs that imagination is the cause of the maladies attributable to the influence of magnetism.

Les Mondes. Vol. xxxv., No. 1. September 3, 1874.

Magneto-Mechanical Sorter.—By M. Charles Vavin.—The object of this invention is to mechanically separate iron chippings and dust from the copper found mixed with the detritus and filings of factories. This sorting is ordinarily accomplished by hand. It takes up much time, and injures the workmens' health, on account of stooping all day over powdered materials containing copper. M. Vavin's apparatus consists of two hollow superposed cylinders revolving in the same direction, upon which the material to be sorted is spread by a hopper. The surface of these cylinders is formed by soft iron bands maintained in a continuous magnetic condition by magnets. To the surface of these cylinders then the iron particles attach themselves, and at a certain time they are detached by revolving brushes, and thrown into a side box, whilst the copper and earthy particles fall to the bottom of the apparatus. M. Mangon says he has used this apparatus to search for titanous iron in arable lands with such successful results as could never have been attained by any other means—chemical or otherwise.

No. 2. September 10, 1874.

The Multiplicity of the Forks of Lightning.—By M. P. Breton, Chief Engineer of the Ponts-et-Chaussées.—In support of M. E. Nouel's note on *Project for a Simplified Lightning Conductor.* (See TELEGRAPHIC JOURNAL, vol. ii., page 299). We reserve this for a separate translation.

Repertorium fur Experimental Physik. Band x., Heft 2, 3.

On a New Tangent Electrometer for use at Lectures.—Ph. Carl.—An illustrated abstract of this and the following paper will appear in an early number.

Experimental Determination of the Dielectric Constants of Insulators.—L. Boltzman.

Peculiar Phenomena in the Path of the Electric Spark.—A. Töpler.—The sparks given off by a Leyden phial leave a trace when they traverse an isolating surface. This trace is especially characteristic upon plates of glass slightly coated with soot. If the sparks are 4 to 6 centimetres in length, the track is generally a light stripe, about 3 millimetres broad, with a dark central line, the particles of soot being partly thrown aside, and partly accumulated on the central line. There is also a generally very marked knot-like thickening where the lateral movement of the air has been especially violent. Beyond and before this spot the traces of the spark are respectively different. On the side next the positive conductor the track of the spark is bushy and ramified, but not on the negative side. If the track is examined with a magnifying power of from 15 to 20 we find on the positive side, but never on the negative, in the dark axial line a very fine dark zigzag line. From the curves of this line, light, lateral, equidistant streaks proceed, which are inclined towards the axis of the spark in the direction of the movement of the positive electricity.

Bulletino Telegrafico, Anno x., Maggio 1874.

With the exception of an article on light and heavy cables, taken from the TELEGRAPHIC JOURNAL, an account of the International Office at Berne, and the conclusion of the account of the telegraphic improvements exhibited at Vienna, this number consists of personal and other Italian official news.

Revista de Telégrafos. No. 16, Anno xiv., 15 Agosto, 1874.

This number is chiefly taken up with official news. There is a notice of the cable recently laid between Brazil and Portugal; a translation of Captain Colombs' paper on the progress of marine telegraphy, read before the Society of Telegraphic Engineers in London; and an essay on collisions at sea.

The paper on *Animal Meteorologists* is continued. The writer maintains, that in tropical regions the croaking of frogs in the morning is a certain sign of rain at mid-day or in the evening. Mosquitos and other insects, as also spiders, indicate by their movements approaching changes of weather.

Poggendorff's Annalen der Physik und Chemie.

VOL. LIII. (1841).

On the Striking-Distance of the Electric Battery. M. Riess. P. 1.

On Galvanic Currents in certain Peculiar Relations, and on so-called Secondary Currents. M. Pfaff. Pp. 20, 294.

Something further on Transition-Resistance. M. Vorsselman de Heer. P. 31.

Means of Intensifying the Action of Ordinary Voltaic Batteries. P. 276.

On Galvanometry. M. Henrici. P. 277.

An *Experimentum Crucis* for the Contact Theory of the Galvanic Battery, and for the Economical Application of the Battery as a Moving Principle, through Electro-Magnetism. M. Pfaff. P. 303.

Experiments as to the Influence of the Iron Masses of Electro-Magnets on the Strength of Magnetism, with Equal Strength of the Electric Current. M. Pfaff. P. 309.

On the Electricity of Aqueous Vapour of High Tension. M. Pfaff. P. 313.

Seventeenth Series of Experimental Researches on Electricity. Mr. Faraday. Pp. 316, 479, 548.

On M. Becquerel's Remarks as to my Comparative Measurement of the Action of a Copper-Zinc, and a Platinum-Zinc, Couple. M. Jacobi. P. 336.

On some Electro-Nitrogurets. Mr. Grove. P. 363.

On the Voltaic Battery with Two Liquids in Contact. M. Poggendorff. P. 436.

On some Mechanical Phenomena accompanying Electric Discharges. M. Abria. P. 589.

On the Coulomb Torsion Balance as Electroscope. M. Dellmann. P. 606.

A New Electrometer. M. Oersted. P. 612.

On Thermo-Electricity of Tartrite of Potash. M. Hankel. P. 620.

Galvanic Dendrites. M. Preuss. P. 625.

(To be continued).

City and Commercial Notes.

THE Government of the Cape of Good Hope have entered into a contract with Messrs. Warden and Co., of Westminster, for the construction and equipment of several lines of telegraph in that colony and the Orange Free States of South Africa, which will place the Diamond Fields, and other remote parts of the Colony, in connection with Cape Town. The construction of these lines will be attended with great difficulties, as the country through which the lines pass is for the most part uninhabited, and without vegetation, food, or water. The country is without roads, and forage and water for the cattle will have to be carried great distances. For some of the lines we understand iron poles will have to be resorted to, wood being unprocurable in the neighbourhood, and its carriage from the coast costing fully four pence per pound.

The fifth Anglo-American cable was successfully completed at 1 A.M. on the 8th ult.

The Eastern Telegraph Company have announced the payment on the 14th inst. of the usual interim dividend of 2s. 6d. per share, free of income tax, for the quarter ended the 30th June, 1874. The register of transfers will be closed from the 6th to the 14th, both days inclusive.

The Western Union Telegraph Company of New York have declared a dividend of 2 per cent for the past quarter.

Owing to the improved receipts of the Indo-European Telegraph Company, Limited, for the half-year ending June 30th, coupled with a certain amount of relief which the board have obtained from the Indian Government, and a reduction of the transit rates acceded to by the Imperial Russian Government, the board are enabled to declare an interim dividend for the half-year ending the 30th of June last at the rate of 5 per cent. per annum, free of income tax. The board also state that there is an early prospect of reduction in the present heavy payments made for the rent of the special wire to the British Post Office. The dividend will be payable on and after the 1st inst.

According to the report read at the meeting on the 16th ult, for the half-year ending the 30th of June last, of the Cuba Submarine Telegraph Company, the balance of the revenue account amounts to £5895 13s. 7d., and the extraordinary expenditure for the repair of the cable to £21,747 2s. 5d., absorbing the whole of the balance at the reserve fund (£12,283 13s. 6d.), and the above profit of the half-year, and leaving £3567 15s. 4d. to be carried forward to the debit of the current account. The receipts since the restoration of the cable have been satisfactory, and show a material increase on those of the corresponding period last year. Arrangements are stated to be in progress whereby it is believed the differences between the company and the West India Company will be brought to an amicable settlement, and a suitable vessel provided and stationed in the West Indies for the repair of both companies' cables. It was also stated that the *Hooper* will sail in about a month to lay the new duplicate cable, which will greatly facitate the transfer of messages over the line.

At a meeting of the board of the Anglo-American Telegraph Company, Limited, held on the 19th inst., it was resolved to pay the usual interim dividend of 1¼ per cent, free of income tax, for the quarter ending the 30th inst. The warrants will be payable on and after the 1st of November. The register of transfers will be closed from the 1st to the 6th of October, both inclusive.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Sept. 30.
Stock	Anglo-American (Limited)	100	81½—82½
10	Brazilian Submarine..	All	7½—7¾
10	Cuba	All	6⅜—6⅝
10	Direct Spanish	9	..—..
20	Direct United States Cable	All	12½—13½
10	Eastern (Limited)	All	8⅜—8⅝
..	Do., New	..	104—106
10	Eastern Extn. Australia and China	All	8—8¼
10	Globe Telegraph and Trust	All	7[illegible]—7⅝
10	Do., 6 per cent Pref...	All	10—10¼
10	Great Northern	All	10¾—11¼
25	Indo-European	All	17½—18½
10	Mediterranean Extension (Limited)	All	4—4½
10	Do., 8 per cent Pref...	All	10¼—10¾
10	Panama and South Pacific	2½	..—..dis
8	Reuter's..	All	11—11½
Stock	Submarine	100	205—210
1	Do., Scrip	All	2—2¼
10	West India and Panama	All	4—4½
10	Do., 10 per cent Pref.	All	10½—10¾
20	Western and Brazilian (Limited) ..	All	11—11½
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	103—105
10	Hooper's Telegraph Works	All	12¼—12¾
50	India-Rubber and Gutta Percha ..	All	21—23
Cert.	Submarine Cables Trust	100	112—115
12	Telegraph Construction	All	32—33
100	Ditto Ditto 7 per cent Bonds	All	103—105

Patents.

NOTICES TO PROCEED.

1251. C. Groubman, of Odessa, and of Great Portland Street, in the county of Middlesex, "Improved electric apparatus for indicating the progress of trains on railways."

1330. J. Bailey, of Dublin, Civil Engineer, "Improvements in apparatus for locking railway point and signal levers."

1855. G. Zanni, of Highbury, in the county of Middlesex, "Improvements in submarine and other telegraphic cables."

2314. R. Spence, of the firm of Murch and Spence, of Bridgwater, in the county of Somerset, Engineers, "Improvements in apparatus or interlocking levers for switches, points, and signals of railways."

3648. A. M. Clark, of 53, Chancery Lane, in the county of Middlesex, Patent Agent, "Improvements in electro-magnetic governors for steam heating and drying apparatus."—A communication to him from J. M. Bradford, of Portland, U.S.

2637. G. K. Winter, F.R.A.S., Arconum, "Improvements in electrical inter-communication in trains."

1367.—A. Haghe, Civil Engineer, of Stockwell, "Improvements in apparatus for working signals."

1492. H. J. Brook, E. G. Draper, and J. Unwin, of Sheffield, "Improvements in the preparation of articles to be electro-plated or coated with nickel and other metals by electricity."

1893. R. E. Cooper, of 37, Kensington Terrace, Hyde Park, Leeds, and F. Campin, of 58, Fenton Street, Leeds, "Improvements in apparatus for locking railway signals and switches, and for locking railway signals and gates at level crossings."

1568. W. Pinkerton, of Londonderry, "Improvements in apparatus for communicating or signalling between parts of railway trains."

GRANTS FOR PROVISIONAL PROTECTION FOR SIX MONTHS.

2619. H. Cole, 21, Billiter Street, E.C., "An automatic fire alarm."—A communication to him from abroad by Messrs. Klingelhoefer & Co., of Rio de Janeiro, Brazil.

2724. R. Currer, of Glasgow, "Improvements in signalling on railways, and in apparatus therefor."

2782. W. Darley, of Deptford, Kent, "Improvements in apparatus for raising sunken, and for removing stranded, ships or vessels, also for lifting heavy weights under water, and for aiding in the performance of submarine engineering operations."

APPLICATIONS FOR LETTERS PATENT.

2837. H. Handyside, of St. John's Wood, in the county of Middlesex, Engineer, "Improvements in the manufacture of chains or cables." *Dated August* 18, 1874.

3006. H. Highton, M.A., of Putney, in the county of Surrey, "Improvements in submarine telegraphy." *Dated September* 2, 1874.

3037. W. R. Lake, of the firm of Hazeltine, Lake, & Co., Southampton Buildings, London, "Improved printing telegraph apparatus."—A communication to him from abroad by George Washington Howe, of Stevenson, Alabama, U.S.A. *Dated September* 4, 1874.

THE TELEGRAPH BETWEEN GREAT BRITAIN AND IRELAND.—Telegraphic communication with Ireland is maintained by means of four submarine cables, submerged between different points in Great Britain and the Irish Coast. These cables contain in all twenty-two separate wires, apportioned among the different routes as follows:—Holyhead and Dublin, seven wires; Wexford, four wires; Belfast, seven wires; and Portpatrick and Donaghadee, four wires. These wires, again, are apportioned among the different towns in Ireland as follows:—Dublin, nine; Belfast, eight; Cork, Waterford, and Londonderry, each one; and Valentia, the landing-place of the Anglo-American Company's cables, two. The towns in England and Scotland having direct communication with Ireland are—London, Manchester, Liverpool, Newcastle, Glasgow, and Stranraer. The system, it will thus be seen, is somewhat extensive and complicated, and the expense of maintaining it necessarily heavy. One of the largest cables—that between Holyhead and Dublin—has been laid since the Post-Office acquired the control of the telegraphs, and all of them have been under repair during the same period. The rocky nature of the bottom along the Anglesea coast has, it appears, seriously affected the condition of the Holyhead and Dublin line, the newest of all the Irish cables; in many places the outer iron wires which form the chief protection of the core have been completely chafed through from constant friction. Quite a new feature has also developed itself in connection with this "fault,"—viz., the eating away, by a kind of worm, of the gutta-percha covering of the core, in much the same way as wood is bored and eaten away by these destructive insects. The Post-Office can hardly be congratulated on the possession of these lines to Ireland, as they have been a constant source of trouble and expense ever since the transfer of the telegraphic system to the Government. But it may very fairly be congratulated on the energy and promptitude with which it has undertaken the necessary works of repair in every instance, and the success which has generally attended its efforts to restore the means of communication at the earliest possible moment. It may not be out of place to mention here that the interruption to the Irish communication told somewhat seriously against the business which arose in connection with the recent meeting at the British Association at Belfast. The loss of seven wires out of a total of twenty-two was, of course, a very serious matter, and the difficulty which had to be faced by the Post-Office was, that instead of Dublin being able to give up some of its wires to Belfast, the latter had to relinquish no fewer than three of its ordinary wires, in order to make good the usual cross-channel service. Notwithstanding this, however, we learn that no fewer than 405,000 words of press matter, being considerably more than 200 columns, were transmitted in connection with the meeting. The number of press messages in which this amount of matter was contained was close upon 900, while an almost equal number of private telegrams was created by the event. Necessarily, some portion of the matter telegraphed was too late for publication next morning, for we learn that on the busiest night of the meeting nearly 80,000 words—equal to forty volumes—had to be transmitted. Having regard, however, to the vastly diminished resources of the department, the work appears to have been singularly well done, and we can point to more than one occasion on which we were able to appear with from five to six columns of telegraphic matter. We noticed that the department followed its usual course on important occasions of this kind by opening an office for the receipt and transmission of telegrams in the Queen's College, where were the reception-rooms of the Association, and we are glad to learn that the privilege was so largely taken advantage of that close upon 700 messages resulted from the arrangement.—*Times.*

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE TELEGRAPHIC JOURNAL" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER.

PROFESSOR FOSTER'S PAPER "ON THE GEOMETRICAL TREATMENT OF OHM'S LAW."—Owing to the Author's proof not having come to hand, some little alteration that was necessary was not made in the Paper that appeared in our last issue; but a fuller and corrected report by Professor Foster we hope shortly to present to our readers.—*Ed.* TEL. JOURN.